

INSTRUCTION BOOK

MODEL 91B-71A

RF VOLTMETER

**BOONTON**  
**ELECTRONICS**  
CORPORATION



I N S T R U C T I O N   B O O K

M O D E L   91B-31A

R F   V O L T M E T E R

91B  
8-63

**BOONTON**  
**ELECTRONICS**  
CORPORATION



ROUTE 287 AT SMITH ROAD  
PARSIPPANY, N. J. - 07054



## TABLE OF CONTENTS

| Section |                                         | Page |
|---------|-----------------------------------------|------|
| I       | SPECIFICATIONS                          | 1    |
| II      | GENERAL DESCRIPTION                     | 2    |
| III     | CIRCUIT DESCRIPTION                     | 5    |
| IV      | OPERATING PROCEDURE                     | 6    |
|         | 4-1. General                            | 6    |
|         | 4-8. Overload Effects                   | 7    |
|         | 4-10. Ambient Temperature Effects       | 7    |
|         | 4-12. 60 Cycle Pick-Up                  | 7    |
| V       | MAINTENANCE                             | 9    |
|         | 5-1. Periodic Checking                  | 9    |
|         | 5-6. Effect of Line Voltage on Accuracy | 10   |
|         | 5-8. Replacement of Meter Lamps         | 11   |
|         | 5-10. Field Replacement Components      | 11   |
| VI      | TABLE OF REPLACEABLE PARTS              | 12   |
| VII     | WARRANTY                                | 18   |
| VIII    | SHIPPING INSTRUCTIONS                   | 19   |



## LIST OF ILLUSTRATIONS

| Figure |                                                                  | Page |
|--------|------------------------------------------------------------------|------|
| 2-1    | Input Capacitance vs. Test Level                                 | 3    |
| 2-2    | Typical VSWR of 91-3B RF Probe With<br>91-8B 50 $\Omega$ Adapter | 3    |
| 2-3    | Probe Resistance Characteristics                                 | 4    |
|        | Schematic                                                        | 20   |



## SECTION I

### SPECIFICATIONS

|                  |                                                 |                                                                             |
|------------------|-------------------------------------------------|-----------------------------------------------------------------------------|
| Voltage Range:   | 1 millivolt to 3 volts.                         |                                                                             |
| Frequency Range: | 50 kilocycles to 500 megacycles.                |                                                                             |
| Accuracy:        | <u>Range-Full Scale</u>                         | <u>Accuracy</u>                                                             |
|                  | .01 to 3 volts                                  | 5% Full Scale to 200 mc<br>10% Full Scale to above<br>200 mc                |
|                  | .003 volt                                       | 10% Full Scale to 500 mc.                                                   |
| Input Impedance: | <u>52 ohm Probe</u>                             | <u>High Impedance Probe</u>                                                 |
|                  | VSWR 1.10 Max.                                  | Approx. Cap = 2.5 $\mu$ f<br>above 1 volt. Shunt<br>resistance (see curve). |
| Power Supply:    | 105 to 125 volts; 55-65 c.p.s. 30 watts         |                                                                             |
| Tubes:           | One 12AX7; one 12AT7; one 0A2; one 6X4          |                                                                             |
| Dimensions:      | 7" wide, 11" high, 9" deep                      |                                                                             |
|                  | Maximum probe extension 33 in. from instrument. |                                                                             |
| Weight:          | 13 lbs.                                         |                                                                             |



## SECTION II

### GENERAL DESCRIPTION

- 2-1. General Description.
- 2-2. The 91B RF Voltmeter is a sensitive instrument designed for the measurement of voltages from 1 millivolt to 3 volts covering a wide frequency range of 50 kilocycles to 500 megacycles. Seven ranges from .003 to 3 volts full scale are provided, plus a continuous calibration in decibels covering a range of 70 db.
- 2-3. Two probes are supplied with each instrument, one being a general purpose high impedance probe and the other having a 52 ohm termination with a BNC coaxial connector for low VSWR measurements up to 500 megacycles.\* Both probes contain a full-wave crystal diode detecting circuit, providing RMS response for all voltage levels below 30 millivolts. The meter, however, is calibrated to read the RMS of a sine wave signal at all voltage levels up to 3 volts.
- 2-4. Even at voltage levels above 30 millivolts, the full-wave detector\* minimizes errors due to non-sinusoidal wave-forms and is free of turnover error. The high impedance probe has a shunt capacitance of approximately 2.5 pf. At high voltage levels, the input capacitance is somewhat lower. See Figure 2-1.
- 2-5. The shunt resistance component is also a variable factor depending upon both voltage and frequency. An approximation of the shunt resistance component may be obtained from curves in Figure 2-3 for various combinations of frequency and voltage. Long-life hermetically sealed germanium diodes are used in both probes.

\* Many instruments have been modernized and the two probes have been replaced by a single probe and a 50  $\Omega$  adapter.



## SECTION III

### CIRCUIT DESCRIPTION

#### 3-1. General.

- 3-1. The RF Voltmeter utilizes a full-wave crystal diode rectifier circuit in each probe where the r-f voltage is converted to a d-c potential, which in turn is converted to a 60 cycle carrier frequency by means of a low-noise chopper. The 60 cycle carrier is then amplified by a high gain feedback amplifier. The amplifier output is rectified and fed into special circuitry which provides approximately linear meter response on all ranges.
- 3-2. The probes are designed with attenuation at 60 cycles to reduce errors which would result if spurious 60 cycle voltage entered the carrier amplifier and mixed with the 60 cycles developed by the chopper.



## SECTION IV

### OPERATING PROCEDURE

- 4-1. General.
- 4-2. Connect the power cord to a suitable a-c power source of from 105 to 125 volts and a frequency between 55 and 65 cycles. Set the power switch to the ON position, and allow a 15 minute warm-up period. A one hour warm-up period, however, is usually required to insure meeting specified accuracy.
- 4-3. Select either the "Hi-Z" or "52 ohm" probe (or single probe with adapter) and connect it to the instrument by means of the special two-conductor flexible shielded cable which is supplied. Check the serial number of the probe to see that it is the same as that of the voltmeter.

#### NOTE

Meter movement should be set on zero calibration mark with power switch turned off. Normal meter deflections with zero input signal on probe (Hi-Z probe shorted at input) are as follows:

| RANGE            | DEFLECTION                    |
|------------------|-------------------------------|
| .003             | 1/8 to 1/4 inch               |
| .01, .03, .1, .3 | Zero                          |
| 1                | Zero or slightly<br>supressed |
| 3                | Suppressed                    |

- 4-4. Set RANGE-FULL SCALE switch to appropriate setting for voltage to be measured.



- 4-5. When using the high impedance probe at high frequencies the ground connection must be as short and direct as possible to minimize errors arising from circulating r-f currents in the ground return impedance. Connection to the high side must also be as short as possible to minimize resonance rise effects at frequencies above 100 megacycles.
- 4-6. When measuring test signal levels greater than .03 volt read appropriate upper scales of meter. If level is below .03 volt read appropriate lower scales of meter.
- 4-7. The 0-10 db scale is designed to be used in conjunction with the db setting of the RANGE-FULL SCALE control. To obtain relative level readings in decibels always add the db meter reading to the db setting of the RANGE control. When used with a good signal generator, the db scale greatly facilitates the measurement of relative attenuation and bandpass characteristics of filter networks.
- 4-8. Overload Effects.
- 4-9. R-f voltages exceeding 10 volts must not be applied to either probe or permanent damage to the crystal diodes may result. Maximum d-c voltage rating for "Hi-Z" probe is 300 volts.
- 4-10. Ambient Temperature Effects.
- 4-11. The specified full scale voltage accuracy will not be met at excessively high or low ambient temperatures. The normal ambient temperature range for specified accuracy is 70° F. to 90° F. Do not place the 91B Voltmeter on top of heat radiating equipment, or excessive temperature may affect accuracy. Avoid making permanent probe connections to sources of heat such as socket terminals on high powered vacuum tubes.
- 4-12. 60 Cycle Pick-Up.
- 4-13. When measuring low level r-f voltages, precautions should be taken to avoid the possibility of erroneous readings



resulting from superimposed 60 or 120 cycle pick-up voltages. Always check for this condition by reducing the r-f test signal to zero and noting residual meter deflection from hum pick-up.



# SECTION V

## MAINTENANCE

### 5-1. Periodic Checking.

5-2. The Model 91B is designed to give long periods of service without maintenance when operated in accordance with these instructions. It is recommended, however, that the instrument be checked occasionally against reliable standards to insure against errors resulting from deterioration of diodes or amplifier tubes. To make these checks it is necessary to have a good signal source in the order of 500 KC with less than 1% distortion at levels up to 3 volts across 50 ohms. A good (averaging response type) electronic voltmeter such as the Ballantine Model 310A to 314 or Hewlett-Packard Model 400D or 400H may be used to monitor the signal source for this purpose.

5-3. A set of full scale comparison readings should be taken using both the high impedance probe and the 52  $\Omega$  probe. Readings taken with the high impedance probe should not differ from those taken with the 52  $\Omega$  probe by a factor greater than indicated in the following table:

| RANGE-FULL SCALE | ALLOWABLE PROBE DIFFERENCE |
|------------------|----------------------------|
| 3 volts          | 2%                         |
| 1 "              | 3%                         |
| .3 "             | 5%                         |
| .1 "             | 3%                         |
| .03 "            | 4%                         |
| .01 "            | 5%                         |
| .003 "           | 6%                         |

5-4. If the probe difference percentages are appreciably greater than prescribed it is likely that the probe producing the lower set of readings is defective and



should be replaced. In this case, it is advisable to return both the instrument and probes to the factory for proper installation and adjustment of new set of matched diodes. If the probe differences are less than prescribed, their average value for each range should agree within 5% of the monitor meter. Be sure the 91B has been adequately warmed up for approximately one hour before making this test. Line voltage should be approximately 117 volts. If the average deviation on the one volt range is appreciably greater than 5%, it is advisable to replace the 12AT7 tube and re-check. If the accuracy is not restored, try replacing the other tubes or selenium rectifier if necessary to obtain required heater voltage on 12AX7 and 6AU6 tubes. Final accuracy adjustment may be made by means of the number 8 adjusting screw located on the top rear of the amplifier chassis.

- 5-5. With the one volt range properly adjusted, the other ranges should fall within tolerance. Individual adjustments are provided, however, on all other ranges and these may be re-set if necessary. Individual range adjustments are located on the side of the amplifier chassis and are numbered as follows:

| RANGE FULL SCALE | ADJUSTMENT NO. |
|------------------|----------------|
| .003 volt        | 1              |
| .01              | 2              |
| .03              | 3              |
| .1               | 4              |
| .3               | 5              |
| 3                | 6              |

5-6. Effect of Line Voltage on Accuracy.

- 5-7. A change of line voltage from 105 volts to 125 volts should produce less than 2% change in meter reading. Changes greater than 2% indicate excessive deterioration of tubes.



5-8. Replacement of Meter Lamps

5-9. On instruments having meters manufactured by Q.V.S., Inc. the lamps may be replaced after removing the two holding screws on the front of the meter cover. Instruments having Marion meters must be removed from their cabinets to permit replacement of lamps from rear of meter.

5-10. Field Replacement Components

The following table lists the most readily replaceable components, their function, and special requirements if any.

| COMPONENTS                    | TYPE NO.                                   | SPECIAL REQUIREMENTS                                  |
|-------------------------------|--------------------------------------------|-------------------------------------------------------|
| Rectifier tube                | 6X4                                        | None                                                  |
| Voltage regulator             | 0A2                                        | None                                                  |
| Amplifier tube                | 12AX7                                      | Low noise, non-microphonic                            |
| Amplifier tube                | 6AU6                                       | None                                                  |
| Amplifier tube                | 12AT7                                      | None                                                  |
| Selenium rectifier            | Federal No. 1016 or<br>Sarkes Tarzian 304B | 11.5 volts minimum DC<br>output across heater<br>load |
| Chopper                       | Stevens-Arnold<br>A-11                     | Specify power line<br>frequency                       |
| Pilot lights &<br>meter bulbs | #47                                        | None                                                  |
| Fuse                          | 1A 3 AG                                    | None                                                  |



## SECTION VI

## TABLE OF REPLACEABLE PARTS

| SYMBOL | DESCRIPTION                                                            | BEC PART NO. |
|--------|------------------------------------------------------------------------|--------------|
| C1     | fixed, met. paper, 0.1 $\mu$ f, $\pm$ 20%, 200V                        |              |
| C2     | fixed, met. paper, 0.1 $\mu$ f, $\pm$ 20%, 200V                        |              |
| C3     | fixed, mylar, 0.022 $\mu$ f $\pm$ 20%, 200V                            |              |
| C4     | fixed, met. paper, 2.0 $\mu$ f, $\pm$ 10% 200V                         |              |
| C5     | fixed, elect (20 $\mu$ f/300V) Part of<br>40-20-20 $\mu$ f/300-300-25V |              |
| C6     | fixed, mylar, 0.1 $\mu$ f $\pm$ 20%, 200V                              |              |
| C7     | fixed, elect. (20 $\mu$ f 25V)                                         |              |
| C8     | fixed, elect., (40 $\mu$ f 300V)                                       |              |
| C9     | fixed, mylar, 0.022 $\mu$ f $\pm$ 20%, 200V                            |              |
| C10    | fixed, met. paper, 0.1 $\mu$ f, $\pm$ 20%, 200V                        |              |
| C11    | fixed, mylar, 0.022 $\mu$ f $\pm$ 20%, 200V                            |              |
| C12    | fixed, mica, 0.001 $\mu$ f                                             |              |
| C13    | fixed, met. paper, 1.0 $\mu$ f $\pm$ 20%, 200V                         |              |
| C14    | fixed, met. paper, 1.0 $\mu$ f $\pm$ 20%, 200V                         |              |
| C15    | fixed, ceramic, 0.001 $\mu$ f                                          |              |
| C16    | fixed, ceramic, 0.001 $\mu$ f                                          |              |
| C17    | fixed, ceramic, 0.001 $\mu$ f                                          |              |
| C18    | fixed, ceramic, 0.001 $\mu$ f                                          |              |



| SYMBOL | DESCRIPTION                                                                                              | BEC PART NO. |
|--------|----------------------------------------------------------------------------------------------------------|--------------|
| C19    | fixed, ceramic, 0.001 $\mu$ f                                                                            |              |
| C20    | fixed, ceramic, 0.001 $\mu$ f                                                                            |              |
| C21    | fixed, elect., 40 $\mu$ f, 450V for<br>Ser. Nos. below 213 20-20 $\mu$ f<br>450V for Ser. Nos. above 213 |              |
| C22    | fixed, elect. 1000 $\mu$ f 15V                                                                           |              |
| C23    | fixed, mylar, .022 $\mu$ f $\pm$ 20%, 200V                                                               |              |
| CH1    | Chopper                                                                                                  |              |
| D1     | Diode, 1N128                                                                                             |              |
| D2     | Diode, selected                                                                                          |              |
| D3     | Diode, selected                                                                                          |              |
| D4     | Diode, selected                                                                                          |              |
| D5     | Diode, selected                                                                                          |              |
| D6     | Diode, selected                                                                                          |              |
| D7     | Diode, 1N128                                                                                             |              |
| F1     | Fuse, 1 amp                                                                                              |              |
| J1     | Plug, 11 pin female                                                                                      |              |
| L1     | Choke, filter                                                                                            |              |
| M1     | Meter, special 200 $\mu$ amp                                                                             |              |
| P1     | Plug, 11 pin male                                                                                        |              |



| SYMBOL                                                                                                                       | DESCRIPTION                             | BEC PART NO. |
|------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------|--------------|
| All deposited carbon resistors are $\pm 1\%$ , 1/4W; all composition resistors are $\pm 5\%$ , 1/2W, unless otherwise noted. |                                         |              |
| R1                                                                                                                           | fixed. carbon deposited, 1 meg.         |              |
| R2                                                                                                                           | fixed. carbon deposited, 1 meg.         |              |
| R3                                                                                                                           | fixed. carbon deposited, 80.6K $\Omega$ |              |
| R4                                                                                                                           | fixed. carbon deposited, 80.6M $\Omega$ |              |
| R5                                                                                                                           | fixed. carbon deposited, 8.87K $\Omega$ |              |
| R6                                                                                                                           | fixed. carbon deposited, 8.87K $\Omega$ |              |
| R7                                                                                                                           | fixed. carbon deposited, 1K $\Omega$    |              |
| R8                                                                                                                           | fixed. carbon deposited, 1K $\Omega$    |              |
| R9                                                                                                                           | fixed. carbon deposited, 191 $\Omega$   |              |
| R10                                                                                                                          | fixed. carbon deposited, 191 $\Omega$   |              |
| R11                                                                                                                          | fixed. carbon deposited, 97.0 $\Omega$  |              |
| R12                                                                                                                          | fixed. carbon deposited, 97.0 $\Omega$  |              |
| R13                                                                                                                          | fixed. composition, 47K $\Omega$        |              |
| R14                                                                                                                          | fixed. composition, 47K $\Omega$        |              |
| R15                                                                                                                          | fixed. composition, 2.2 meg.            |              |
| R16                                                                                                                          | fixed. composition, 1K $\Omega$         |              |
| R17                                                                                                                          | fixed. carbon deposited, 13K $\Omega$   |              |
| R18                                                                                                                          | fixed. variable, 5K $\Omega \pm 20\%$   |              |
| R19                                                                                                                          | fixed. composition, 1 meg.              |              |



| SYMBOL | DESCRIPTION                             | BEC PART NO. |
|--------|-----------------------------------------|--------------|
| R20    | fixed, composition, 2.2 meg.            |              |
| R21    | fixed, carbon deposited, 499K $\Omega$  |              |
| R22    | fixed, composition, 6.8K $\Omega$       |              |
| R23    | fixed, composition, 47K $\Omega$        |              |
| R24    | fixed, composition, 470K $\Omega$       |              |
| R25    | fixed, composition, 1 meg.              |              |
| R26    | fixed, carbon deposited, 2.26K $\Omega$ |              |
| R27    | fixed, carbon deposited, 499K $\Omega$  |              |
| R28    | fixed, composition, 1 meg.              |              |
| R29    | Not used                                |              |
| R30    | fixed, composition, 470K $\Omega$       |              |
| R31    | fixed, composition, 22 ohms             |              |
| R32    | fixed, composition, 1 meg.              |              |
| R33    | fixed, composition, 100 $\Omega$        |              |
| R34    | fixed, composition, 22 $\Omega$         |              |
| R35    | fixed, carbon deposited, 7.5K $\Omega$  |              |
| R36    | fixed, carbon deposited, 3.48K $\Omega$ |              |
| R37    | fixed, composition, 10K $\Omega$        |              |
| R38    | fixed, composition, 10K $\Omega$        |              |
| R39    | Not used                                |              |
| R40    | fixed, carbon deposited, 52 $\Omega$    |              |
| R41    | fixed, composition, 10K $\Omega$        |              |



| SYMBOL | DESCRIPTION                                              | BEC PART NO. |
|--------|----------------------------------------------------------|--------------|
| R42    | fixed, composition, 10K $\Omega$                         |              |
| R43    | Not used                                                 |              |
| R44    | fixed, power wire-wound, 7.5K $\Omega$<br>$\pm 10\%$ 10W |              |
| R45    | fixed, composition, 3.3K $\Omega$                        |              |
| R46    | fixed, composition, 470 $\Omega$                         |              |
| R47    | fixed, variable composition, 15K $\Omega$<br>$\pm 20\%$  |              |
| R48    | fixed, variable composition, 1K $\Omega$<br>$\pm 20\%$   |              |
| R49    | fixed, variable composition, 1K $\Omega$<br>$\pm 20\%$   |              |
| R50    | fixed, variable composition, 1K $\Omega$<br>$\pm 20\%$   |              |
| R51    | fixed, variable composition, 1K $\Omega$<br>$\pm 20\%$   |              |
| R52    | fixed, variable composition, 200K $\Omega$<br>$\pm 20\%$ |              |
| R53    | fixed, variable composition, 200K $\Omega$<br>$\pm 20\%$ |              |
| R54    | fixed, composition, 330K $\Omega$                        |              |
| R55    | fixed, composition, 1K $\Omega$                          |              |
| R56    | fixed, composition, 470 $\Omega$                         |              |
| R57    | fixed, composition, 470 $\Omega$                         |              |
| R58    | fixed, composition, 1K $\Omega$                          |              |



| SYMBOL | DESCRIPTION                                  | BEC PART NO. |
|--------|----------------------------------------------|--------------|
| R59    | fixed. composition, $33 \Omega \pm 5\%$ 1W   |              |
| R60    | fixed. composition, 15K $\Omega$             |              |
| R61    | fixed. composition. 5.6K $\Omega \pm 5\%$ 2W |              |
| SR1    | Rectifier, selenium                          |              |
| S1     | Switch, special                              |              |
| S2     | Switch, toggle, DPST                         |              |
| T2     | Transformer, power                           |              |
| V1     | Tube, electron. 12AX7                        |              |
| V2     | Tube, electron. 6AU6                         |              |
| V3     | Tube, electron, 12AT7                        |              |
| V4     | Tube, electron, 6X4                          |              |
| V5     | Tube, electron, 0A2                          |              |



## WARRANTY

BOONTON ELECTRONICS CORPORATION guarantees to the original purchaser that each instrument it manufactures be free from defects in material and workmanship for a period of one year after date of initial shipment. Our liability is limited to repairing or replacing any defective part with the exception of vacuum tubes, panel lamps, fuses, and batteries. The warranty lapses if, upon our examination, we judge that the instrument has been abused in any way.

### PROCEDURE TO FOLLOW WHEN INSTRUMENT IS DEFECTIVE

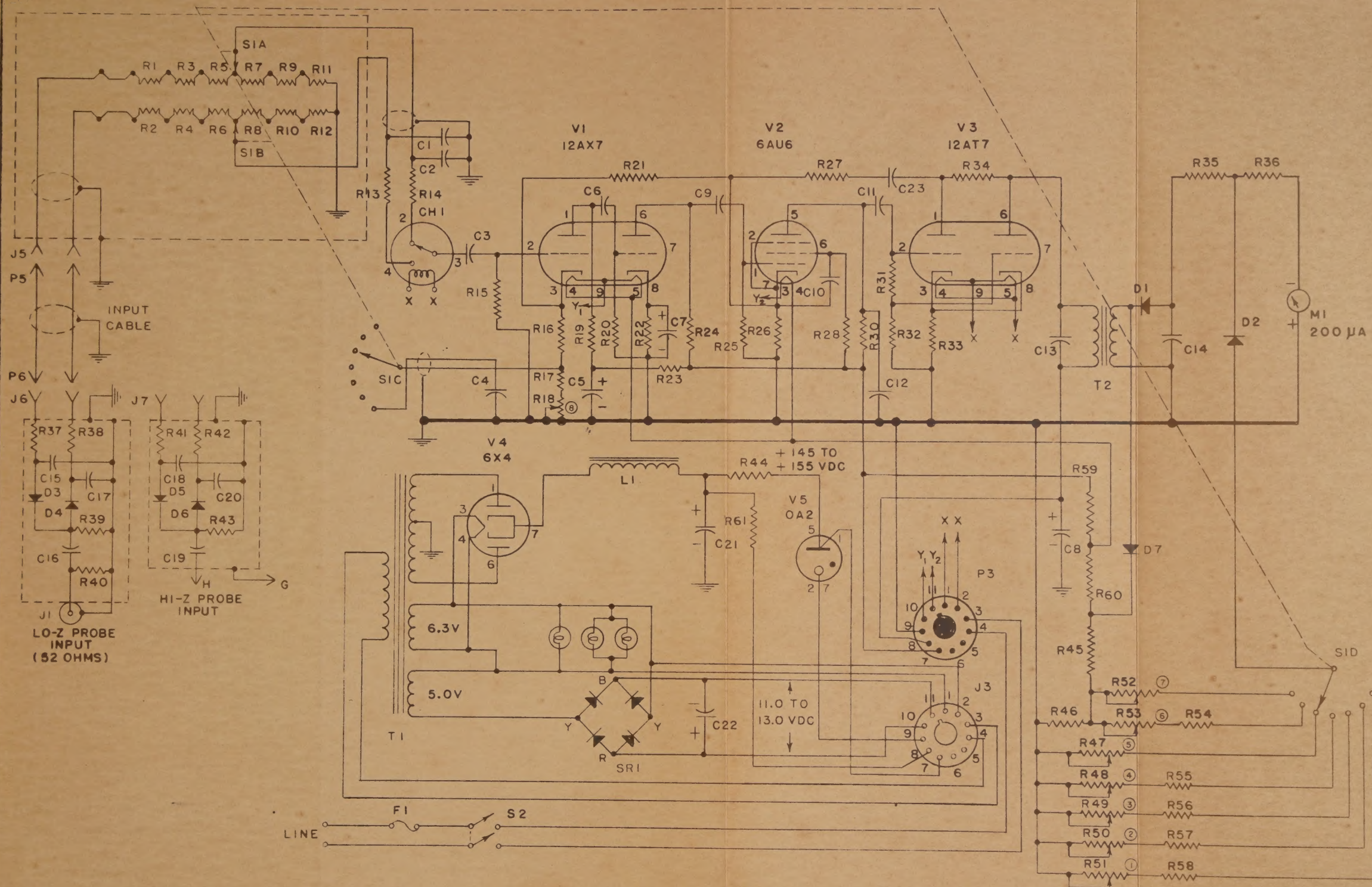
1. Call our plant or our representative nearest you. A simple solution may result from discussion of the problem with our trained personnel.
2. If the fault is not readily eliminated, prepare the instrument for return to us. Pack carefully in a sturdy container using several inches of shock absorbing material on all six sides of the instrument. Include all probes, cables or accessory units. On all paper work pertaining to the returned instrument, note the model and serial number and state briefly the details of the fault. Ship to us transportation charges prepaid.
3. If the instrument is within the warranty, we will repair and return to you transportation charges prepaid. If the instrument is beyond the one year warranty period, we will repair and return it, unless approval on a cost estimate is requested. If the instrument is within the one year warranty period, but our examination reveals abuse, we will await approval of our cost estimate before proceeding with repairs.



SECTION VIII  
SHIPPING INSTRUCTIONS

- 8-1. If it becomes necessary to ship the instrument for any reason the following steps should be followed.
  - a. Wrap the instrument with heavy wrapping paper and seal the seams with gummed tape. Place in fibreboard carton large enough to permit three inches of soft packing material between instrument and sides of box.
  - b. Separately wrap with heavy paper and pad the proper serial number probe and serialized resistance termination or other probe parts being shipped.





RF VOLTMETER  
 MODEL 91-A & 91-B  
 SCHEMATIC DIAGRAM 91007  
 REV. ABC





[www.manualsplus.com](http://www.manualsplus.com)



1002514